and the ice ran out freely for a few hours, after which it stopped moving. During the 30th–31st the ice gorge continued at Fort Buford. On the 31st navigation opened at Sioux City, Iowa.

Lake Erie.—On the 4th the ice on the lake and in the river was broken up by a severe gale; 10th, ice considerably broken by a gale; 15th, ice badly broken by a gale and drifting down the river in large fields; 23d, ice drifting down the river in large fields. On the 5th the inner harbor at Cleveland, Ohio, was full of ice from 4 to 6 inches thick, and outside of the breakwater ice 6 to 10 inches thick extended as far as could be seen; this ice was driven in by a ne. wind. On the 10th nearly all the ice was driven out of the harbor by s. wind. On the 12th the first steamer of the season arrived from Detroit and returned on the 15th, being the first departure of the season. On the 24th the lake was covered with pack ice as far as could be seen. On the 29th no ice was visible.

Lake Huron.—On the 23d the south end of the lake was covered with floating ice and the Saint Clair River was full of floating ice. The night of the 24th communication by boat with points south of Marine City was closed, and on the 25th navigation was entirely closed on the Saint Clair River. On the 30th the ice jam in the Saint Clair River at Marine City gave way and navigation between local points resumed. On the 31st the lake was covered with floating ice at Port Huron and there was no marked indication of a resumption of navigation. At Alpena, Mich., the river and bay were clear of ice on the 28th. A schooner which left for Sand Beach on that date was obliged to return on account of ice in Thunder Bay.

Lake Michigan.—On the 3d 5 steamers were fast in the ice at Milwaukee, Wis.; 5th, ice drifted into harbor and the harbor was blocked by ice at night; 6th, the wind piled the ice on shore; 9th, harbor free of ice. On the 29th 2 boats, the first of the season, arrived at Manistee, Mich., and the channel was free of ice at Green Bay, Wis.

Heights of rivers above low-water mark, March, 1891 (in feet and tenths).

Stations.	Danger-point on gauge.	Highest water.		Lowest water.		Monthly range.
		Date.	Height.	Date.	Height.	
Red River.						
Shreveport, La	29.9	1	21.2	30	15.9	5.3
Arkansas River.						
Fort Smith, Ark	22.0	31	12.9	23	3.8	9.1
Little Rock, Ark	23.0	1, 10	12.7	28	8.5	4.2
Missouri River.						
Fort Buford, N. Dak*						
Kansas City, Mo	21.0	27	12.2	2	4.0	8.2
Mississippi River.						
Saint Paul, Minn*	14.0					
La Crosse, Wis*	13.0					
Dubuque, Iowa*	16.0					
Davenport, Iowa†	15.0	25	7.1	12	2.3	4.8
Keokuk, Iowa	14.0	28	11.0	16	1.8	9.2
Saint Louis, Mo	30.0	30, 31	19.3	15, 16	6.8	12.5
Cairo, Ill	40.0	4, 5, 6	46.2	30	41.9	4.3
Memphis, Tenn	33.0	10	34.9	1	33.0	1.9
Vicksburg, Miss	41.0	31	48.0	1	43.5	4.5
New Orleans, La	13.0	17, 18	16.4	1	14.7	1.7
Ohio River.						
Pittsburgh, Pa	22.0	14	13.8	7, 8	6.1	7.7
Parkersburgh, W. Va	38.0	16	21.9	7	10.4	11.5
Cincinnati, Ohio	45.0	1	50.3	24	32.2	18.1
Louisville, Ky	24.0	1	30.4	25, 26	12.1	18.3
Cumberland River.						
Nashville, Tenn	40.0	14	49.3	25	12.5	36.8
Tennessee River.						
Chattanooga, Tenn	33.0	11	38.9	26	10.4	28.5
Knoxville, Tenn	29.0	10	16.9	26	5.0	11.9
Monongahela River.						
Pittsburgh, Pa	29.0	14	13.8	7, 8	6.1	7.7
Savannah River.						
Augusta, Ga	32.0	10	35.5	4, 5	11.8	23.7
Willamette River.						
Portland, Oregon	15.0	28	6.0	8	1.9	4.1

*Frozen. †For 21 days.

ATMOSPHERIC ELECTRICITY.

AURORAS.

Auroras were reported as follow: 3d, Clinton and Marshalltown, Iowa; Eastport, Me.; Fort Buford, N. Dak.; Kimball and Webster, S. Dak.; Medford, Wis. 4th, Clinton, Iowa. 5th, Ship Island, Miss. 6th, Clinton and Webster City, Iowa; Eastport, Me. 11th, Montevideo, Minn. 12th, Alta, Iowa; Caldwell, Mich.; Morris, Minn.; Webster, S. Dak. 13th, Saint Paul, Minn; Ithaca, N. Y. 14th, Eastport, Me.; Cambridge and Fall River, Mass.; University, Miss. (first ever observed); Wedgewood, N. Y. 15th, Eastport, Me. 16th, Bar Harbor, Me.; Eagle's Mere, Pa. 17th, Alta, Iowa; Orono, Me. 18th, Webster City, Iowa. 26th, Coopersburgh, Pa. 28th, Amherst, Mass. 29th, New Hartford, Conn.; Moorestown, N. J. 30th, New Hartford, Southington, and Voluntown, Conn.; Sandwich, Ill.; Cornish and Orono, Me.; Amherst, Blue Hill Observatory, Cambridge, Concord, Fall River, Newburyport, North Billerica, and Royalston, Mass.; Berlin Mills, Groveton, Nashua, and Plymouth, N. H.; Moorestown, N. J.; Lowville and Wedgewood, N. Y.; Dyberry and Eagle's Mere, Pa.; East Berkshire and Northfield, Vt. 31st, Alta, Iowa; Eastport and Orono, Me.; Plymouth, N. H.; Kimball, S. Dak.; Northfield, Vt.

THUNDER-STORMS.

Thunder-storms were reported as follows: east of the Rocky Mountains thunder-storms were reported in the greatest number of states, 16, on the 7th; in 15 on the 30th; in 11 on the 21st and 29th; in 10 on the 8th; in 9 on the 9th; in 8 on the 6th, 20th, 22d, 25th, and 26th; in 7 on the 31st; in 6 on the 3d and 18th; in 4 on the 2d, 19th, 24th, 27th, and 28th; in 3 on the 5th, 10th, and 12th; in 2 on the 1st, 11th, 13th, 16th, 17th, and 23d, and in 1 on the 15th. The 4th and 14th were the only dates on which no thunder-storms were reported.

East of the Rocky Mountains thunder-storms were reported on the greatest number of dates, 13, in Ky. and Tex.; on 12 in N. C. and Tenn.; on 11 in Fla.; on 10 in Ill., Miss., and Mo.; on 9 in S. C.; on 8 in Ala., Ark., and La.; on 7 in Ga. and Kans.; on 4 in Ind.; on 3 in Iowa, Mass., N. J., and Okla. T.; on 2 in Conn., Md., Minn., Nebr., N. H., Ohio, Pa., Va., and Wis.; and on 1 in Mich., N. Y., and W. Va. West of the Rocky Mountains thunder-storms were reported as follows: Ariz., 6th, 11th, 18th, 21st to 24th, 30th, and 31st; Cal., 1st, 5th, 15th, 16th, 22d, 26th, and 27th; Colo., 17th and 28th; Idaho, 25th, 26th, and 27th; N. Mex., 11th, 21st, 22d, and 23d; Utah, 22d, 27th, and 31st. In Del., D. C., Ind. T., Me., Mont., Nev., N. Dak., Oregon, R. I., S. Dak., Vt., Wash., and Wyo., no thunder-storms were reported.

MISCELLANEOUS PHENOMENA.

SUN SPOTS.

Mr. D. E. Hadden, Alta, Iowa: 1st, 1 group, 2 spots; group in faculæ w. 3d, faculæ disappearing by rotation on w. limb. 5th, 1 group, 1 spot; group e. limb by rotation. 6th, 2 groups, 3 spots; groups e. and se.; faculæ e. and w. 8th, 1 group, 4 spots. 9th, 1 group, 6 spots; faculæ e. 10th, 1 group, 6 or 8 spots; group n. latitude on meridian. 11th, 1 group, 4 spots. 12th, 1 group, 2 spots; prominent faculæ by rotation on se. limb, followed by aurora in the evening; faculæ near e. and w. limbs. 13th, 1 group, 1 spot; large spot by rotation, just in on e. limb; group which was nw. on 12th had vanished. 14th, 1 group, 1 spot; faculæ by rotation se. limb. 15th, 1

group, 1 spot; faculæ disappearing by rotation on w. and nw. limbs; group faculæ by rotation on e. limb; large spot, had well developed umbra and penumbra. 16th, 2 groups, 3 spots; small new group nw. 17th, 2 groups, 6 spots; could not see faculæ or count spots. 18th, 2 groups, 5 spots; large group faculæ by rotation on e. limb; aurora preceding evening; large spot n. latitude, other group nw. limb. 19th, 2 groups, 3 spots; large spot on meridian; group in faculæ disappearing by rotation nw. limb. 20th, 1 group, 1 spot. 22d, 1 group 1 spot nw.; faculæ w. 27th, faculæ e. and w. 30th, 1 group, 1 spot; single glimpses through clouds; group about 1 day in on e. limb, with umbra and penumbra. Cloudy 2d, 7th, 21st, 23d to 26th, 28th, 29th, and 31st.

Mr. John W. James, Riley, Ill.: none seen until 5th, then large spot near east edge; prominent faculæ and faint spot on southeast edge. 6th to 8th cloudy. 9th 1 group near sun's meridian in north latitude. 12th, 13th, prominent faculæ on southeast edge. 13th, the large spot that disappeared by solar rotation February 26th reappeared on east edge. 14–17th, only this one spot seen. 18th–22d, cloudy. 23d, this large spot 2 days from west edge. 24th, cloudy. 25th, no spots. 26–28th, cloudy. 29th, 1 large new spot on east edge. 30th, 31st cloudy.

Mr. H. D. Gowey, North Lewisburgh, Ohio: sun spots were observed on the 10th, 15th, 16th, 17th, and 29th.

Haverford College Observatory, Pa. (observed by Prof. F. P. Leavenworth):

Date.	Number of new—		Disappeared by solar rotation.		Reappeared by solar rotation.		Total number visible.		Faculæ.	Remarks.
	Groups.	Spots.	Groups.	Spots.	Groups.	Spots.	Groups.	Spots.	Groups.	
March, 1891.										
1, 10 a. m...	0	0	0	0	0	0	1	9	1	Definition poor: spots small.
2, 9 a. m...	0	0	0	0	0	0	1	5	1	Definition bad.
4, 12 m	2	4	0	0	0	0	2	4	3	Definition fair; 1 large spot.
5, 10 a. m...	1	2	0	0	0	0	3	6	3	Definition fair; 1 large spot.
6, 10 a. m...	0	0	0	0	0	0	2	2	....	Definition bad.
10, 9 a. m...	0	16	0	0	0	0	1	18	0	Definition fair.
11, 9 a. m...	0	1	0	0	0	0	1	19	1	Definition fair.
14, 9 a. m...	1	1	0	0	0	0	2	3	3	Definition good; 1 large spot.
15, 9 a. m...	0	0	0	0	0	0	1	1	3	Definition poor; 1 large spot.
16, 9 a. m...	2	7	0	0	0	0	3	8	1	Definition poor; 1 large spot.
17, 9 a. m...	0	3	0	0	0	0	2	9	1	Definition poor; 1 large spot.
18, 10 a. m...	1	8	0	0	0	0	3	17	2	Definition good; 1 large spot.
23, 3 p. m...	0	0	0	0	0	0	2	7	1	Definition fair; 1 large spot.
24, 3 p. m...	0	0	0	0	0	0	1	1	2	Definition poor.
25, 9 a. m...	0	0	0	0	0	0	1	1	5	Definition fair.
29, 3 p. m...	4	20	1	1	0	0	4	20	2	Definition fair; 1 large spot.
30, 9 a. m...	0	0	0	0	0	0	3	8	2	Definition poor.

VERIFICATIONS.

[Verifications made by Assistant Professor C. F. Marvin, assisted by Mr. H. E. Williams, chief clerk of the Forecast Division.]

FORECASTS FOR 24 HOURS IN ADVANCE.

The forecasts for districts east of the Rocky Mountains for March, 1891, were made by assistant Professor H. A. Hazen, Signal Service, and those for the Pacific coast districts were made at San Francisco, Cal., by 2d Lieutenant John P. Finley, 19th Infantry.

Percentages of forecasts verified, March, 1891.

States.		States.	
Maine	85.4	Kentucky	79.9
New Hampshire	79.4	Ohio	83.9
Vermont	79.8	West Virginia	83.2
Massachusetts	75.3	Indiana	79.4
Rhode Island	76.5	Illinois	81.1
Connecticut	80.8	Lower Michigan	79.4
Eastern New York	76.6	Upper Michigan	84.5
Western New York	77.1	Wisconsin	87.7
Eastern Pennsylvania	87.4	Minnesota	83.5
Western Pennsylvania	81.9	Iowa	81.8
New Jersey	84.3	Kansas	80.0
Delaware	87.9	Nebraska	81.2
Maryland	86.3	Missouri	89.9
District of Columbia	85.7	Colorado	79.5
Virginia	83.9	North Dakota	77.7
North Carolina	81.3	South Dakota	82.4
South Carolina	79.7	Southern California*	93.4
Georgia	79.5	Northern California*	81.7
Eastern Florida	86.7	Oregon*	78.5
Western Florida	83.9	Washington*	84.1
Alabama	80.5	*By elements:* Weather	87.2
Mississippi	81.1	Temperature†	73.0
Louisiana	74.9	Monthly percentage of weather and temperature combined‡	81.5
Texas	80.3		
Arkansas	78.3		
Tennessee	75.9		

*In determining the monthly percentage of weather and temperature combined, the Pacific coast states are not included. †The forecasts of temperature in districts east of the Rocky Mountains for March, 1891, were made with reference to the maximum temperature alone; that is, a prediction of warmer or cooler indicated that the maximum temperature of the day designated would be higher or lower than the maximum of the previous day. ‡The monthly percentage of weather and temperature combined is determined by multiplying the percentage of weather by 6, and the percentage of temperature by 4, and dividing their sum by 10.

FORECASTS FOR 48 AND 72 HOURS IN ADVANCE.

Appreciating the great importance that long time predictions possess for the general public the Chief Signal Officer has authorized forecasts for 48 and 72 hours, covering the 2d and 3d days in advance. These are optional with the forecast official, and are only made when clearly in the public interest, and cover, in all cases, considerable areas of country, and are not confined to localities.

Percentages of verifications of forecasts made for second day in advance. Number of predictions made: weather, 49; temperature, 23. Percentages of verifications: weather, 76.9; temperature, 100.0; weather and temperature combined, 82.4.

Percentages of verifications of forecasts made for third day in advance. Number of predictions made: weather, 6; percentage, 53.3.

WIND SIGNALS FOR MARCH, 1891.

Statement showing percentages of justifications of wind signals for the month of March, 1891:

Wind signals.—(Ordered by Assistant Professor H. A. Hazen). Total number of signals ordered, 114; justified as to velocity, wholly, 94, partly, 7; justified as to direction, 111. Of the signals ordered 79 were cautionary, of which 63 were wholly and 4 partly justified; and 35 were storm signals, of which 31 were wholly, and 3 partly justified. 69 signals were ordered for easterly winds, of which 67 were justified, and 45 were ordered for westerly winds, of which 44 were justified. Percentage of justifications, 82.1.

COLD-WAVE SIGNALS AND TEMPERATURE-FALL WARNINGS.

[Ordered by Assistant Professor T. Russell.]

Number of cold-wave signals ordered, 114; justified, 59. Percentage of justifications, 51.8. Number of temperature-fall warnings, 74; justified, 26. Percentage of justifications, 35.1. Percentage of justifications of cold-wave signals and temperature-fall warnings combined, 47.7.

Percentages of verifications of weather and temperature signals reported by directors of the various State Weather Services for March, 1891.

States.	Weather.	Temperature.	States.	Weather.	Temperature.
Illinois	75	66	New Jersey	85	88
Indiana	86	89	New York	83	88
Iowa	78	90	North and South Dakota	73	84
Kansas	89	92	Ohio	92	95
Michigan	83	83	Pennsylvania	90	90
Minnesota	77	81	South Carolina	79	81
Missouri	79	85			